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August 26, 2004

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SILOS 1 and 2 PROJECT TRANSPORTATION AND DISPOSAL PLAN

40750-PL-0018, REV. 1

August 26, 2004

APPROVED BY:

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FERNALD CLOSURE PROJECT
FERNALD, OHIO

U.S. DEPARTMENT OF ENERGY

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RECORD OF ISSUE/REVISIONS

EFFECTIVE DATE	REV. NO.	DESCRIPTION
August 5, 2004	0	New plan issued to describe transportation and disposal operations for Silos 1 and 2 materials.
August 26, 2004	1	Revised plan issued to incorporate comments from DOE review for submittal to USEPA/OEPA

ACRONYMS

ACEM	Activity Concentration for Exempt Material
AEA	Atomic Energy Act
AEDO	Assistant Emergency Duty Officer
ALEC	Activity Limit for Exempt Consignment
ASME	American Society of Mechanical Engineers
Bq	Becquerels
Bq/g	Becquerels per gram
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CRF	Cancer Risk Factor
DOE	Department of Energy
DOT	Department of Transportation
EDO	Emergency Duty Officer
EMS	Emergency Management System
EOC	Emergency Operations Center
ERP	Emergency Response Plan
FCP	Fernald Closure Project
HMR	Hazardous Material Regulations
ILCR	Incremental Lifetime Cancer Risk
IP-2	Industrial Packaging-Type 2
ISMS	Integrated Safety Management System
LCF	Latent Cancer Fatalities
LSA	Low Specific Activity
MCEP	Motor Carrier Evaluation Program
MEF	Material Evaluation Form
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NHASP	Nuclear Health and Safety Plan
NTS	Nevada Test Site
NTSWAC	Nevada Test Site Waste Acceptance Criteria
OU	Operable Unit
PCDF	Permitted Commercial Disposal Facility
Ra-226	Radium 226
Ra-228	Radium 228
RCRA	Resource Conservation and Recovery Act
RCT	Radiological Control Technician
RD/RA	Remedial Design/Remedial Action
RDP	Remedial Design Package
RI	Remedial Investigation
ROD	Record of Decision
RPP	Radiological Protection Program
RSPA	Research and Special Programs Administration
RWP	Radiological Work Permit
SPR	Safety Performance Requirement

SR	State Route
SRC	Safety Review Committee
TBq	Terabecquerels
TBq/g	Terabecquerels per gram
TCLP	Toxicity Characteristic Leaching Procedure
TEP	Transportation Emergency Plan
TEPP	Transportation Emergency Preparedness Program
Th-230	Thorium 230
TSA	Trailer Staging Area
WAC	Waste Acceptance Criteria
WC	Waste Characterization

1.0 INTRODUCTION

1.1 PURPOSE AND SCOPE

This plan describes transportation and disposal operations that will ensure safe and successful staging and transportation of Operable Unit (OU) 4 Silos 1 and 2 material from the Fernald Closure Project (FCP) to the Nevada Test Site (NTS). The currently identified mode of transportation for this material will be direct truck.

This plan serves to: (1) describe the transportation logistics associated with Silos 1 and 2 material; and (2) generally describe operational aspects of transportation plans to demonstrate that Silos 1 and 2 material can be transported to the designated disposal site safely, and in accordance with applicable regulations.

Submittal of this Transportation and Disposal Plan complies with the requirements put forth in the Silos 1 and 2 Remediation Facility Remedial Design Package (40750-RP-0028, Rev. 0, April 2003) which requires an operational description of the transportation and disposal of Silos 1 and 2 material, including on-site staging pending shipment, logistics, packaging configuration, and selected mode of transportation to the selected disposal facility.

The Record of Decision (ROD) Amendment for Operable Unit (OU) 4 Silos 1 and 2 Remedial Action (40700-RP-0008, approved July 13, 2000) requires treatment by chemical stabilization. The Final Explanation of Significant Differences for Operable Unit 4 Silos 1 and 2 Remedial Action (40750-RP-0038, approved November 24, 2003) modifies the Silos 1 and 2 remedy specified in the ROD amendment to allow disposal at a Permitted Commercial Disposal Facility (PCDF), in addition to the already-approved option of disposal at the NTS, and removes the Resource Conservation and Recovery Act (RCRA) Toxicity Characteristic Leaching Procedure (TCLP) analysis as a treatment criterion for the stabilization process.

The NTS is the only currently identified viable disposal option for chemically stabilized Silos 1 and 2 materials. Shipments to the NTS are currently planned to be performed exclusively by direct truck. The current transportation and disposal approach assumes the Silos 1 and 2 material will be chemically stabilized and packaged in 196 ft3, 6-foot diameter, 6.5-foot high, half-inch thick, carbon steel containers, loaded onto flatbed trailers, and transported by truck to the NTS for disposal.

Since this plan is specific to direct-truck transportation and disposal of Silos 1 and 2 material at the NTS, disposal at any other government or commercial site, or use of another mode of transportation, will require a revision of this Transportation and Disposal Plan to reflect the receiving facility's license and permits and/or the alternate transportation mode.

1.2 PROJECT APPROACH

Fluor Fernald is responsible for material retrieval, chemical stabilization, and packaging; selection of the disposal facility and mode of transportation; analysis of the Silos 1 and 2 materials for compliance with the disposal facility's Waste Acceptance Criteria (WAC); loading Silos 1 and 2 materials for shipment; and transporting the Silos 1 and 2 materials to the disposal facility. Plans and requirements for completing this scope are described in the Silos 1 and 2 Project Remedial Design/Remedial Action (RD/RA) Package (40430-RDP-0001, Rev. 2, December 2003).

2.0 OFF-SITE TRANSPORTATION

2.1 INTRODUCTION

The FCP will conduct its operations in compliance with applicable federal, state, local, and tribal requirements governing materials transportation, unless exemptions or alternatives are approved in accordance with Department of Transportation (DOT) regulations.

2.2 DEPARTMENT OF TRANSPORTATION REQUIREMENTS

DOT regulations, under 49 Code of Federal Regulations (CFR) Part 173.403, categorize low specific activity (LSA) material into three classifications: LSA-I, LSA-II, and LSA-III. To be considered LSA material, the material need only meet criterion under one of the classifications. Evaluation of the radiological content of the Silos 1 and 2 materials indicates these materials meet one criterion for LSA-II material. Specifically, Silos 1 and 2 materials are considered "other material in which the radioactive material is distributed throughout and the estimated average specific activity does not exceed 10-4 A2/g for solids..."

The results of the LSA-II determination on Silos 1 and 2 materials are presented in Appendix A.

The LSA determination drives the container requirements for packaging the Silos 1 and 2 materials for off-site shipment. Based on the evaluation performed, the minimum packaging requirement for the Silos 1 and 2 materials is an Industrial Packaging – Type 2 (IP-2) container. Cylindrical, carbon steel IP-2 containers will be used to containerize the Silos 1 and 2 materials for staging and subsequent shipment and disposal. The containers will be loaded onto flatbed trailers.

2.3 MATERIAL TRANSPORT

Contracts have been awarded to carriers selected to meet the requirements of each shipment and provide safe, expeditious, and economical delivery to the final destination.

Only motor carriers with satisfactory ratings under the Department of Energy (DOE) Motor Carrier Evaluation Program (MCEP) will be utilized.

The FCP provides a detailed briefing to every driver of radioactive material before the shipment departs the FCP. That briefing stresses emergency response actions to take in the unlikely event of an accident or severe weather, instructions for maintenance of exclusive use shipment controls, and the importance of remaining on the routes assigned by FCP. The FCP also requires motor carriers to utilize a satellite tracking system (e.g., Qualcomm) for each shipment and has made arrangements with the motor carriers to access that data as necessary to randomly verify the motor carrier is adhering to the assigned routes. Motor carrier drivers that fail to adhere to the assigned routes are prohibited from hauling future shipments of material for the FCP.

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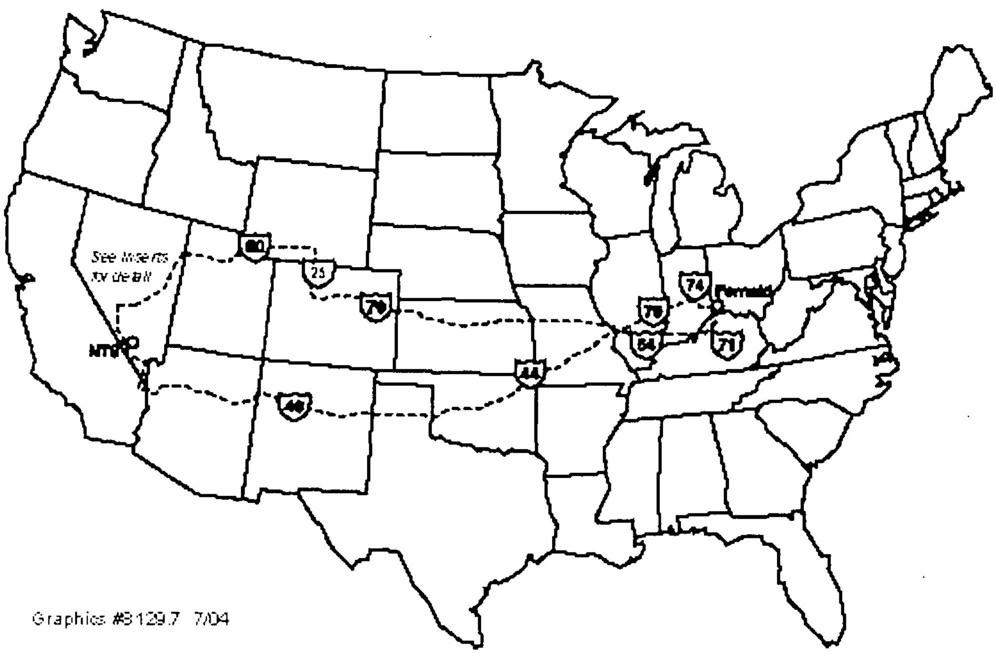
2.3.1 Routes

There is currently one northern route and one southern route that could be used for transportation of Silos 1 and 2 materials to the NTS via truck. It is expected that the majority of the shipments will utilize the northern route. Should the routes change, the motor carrier transporting the material will be notified of the changes and be required to stay on the designated, modified routes. These routes utilize beltways around major metropolitan areas when available. The map below gives a simplified view of the main routes. More specific maps follow each detailed route description.

TRANSPORTATION ROUTES BETWEEN FERNALD AND NTS



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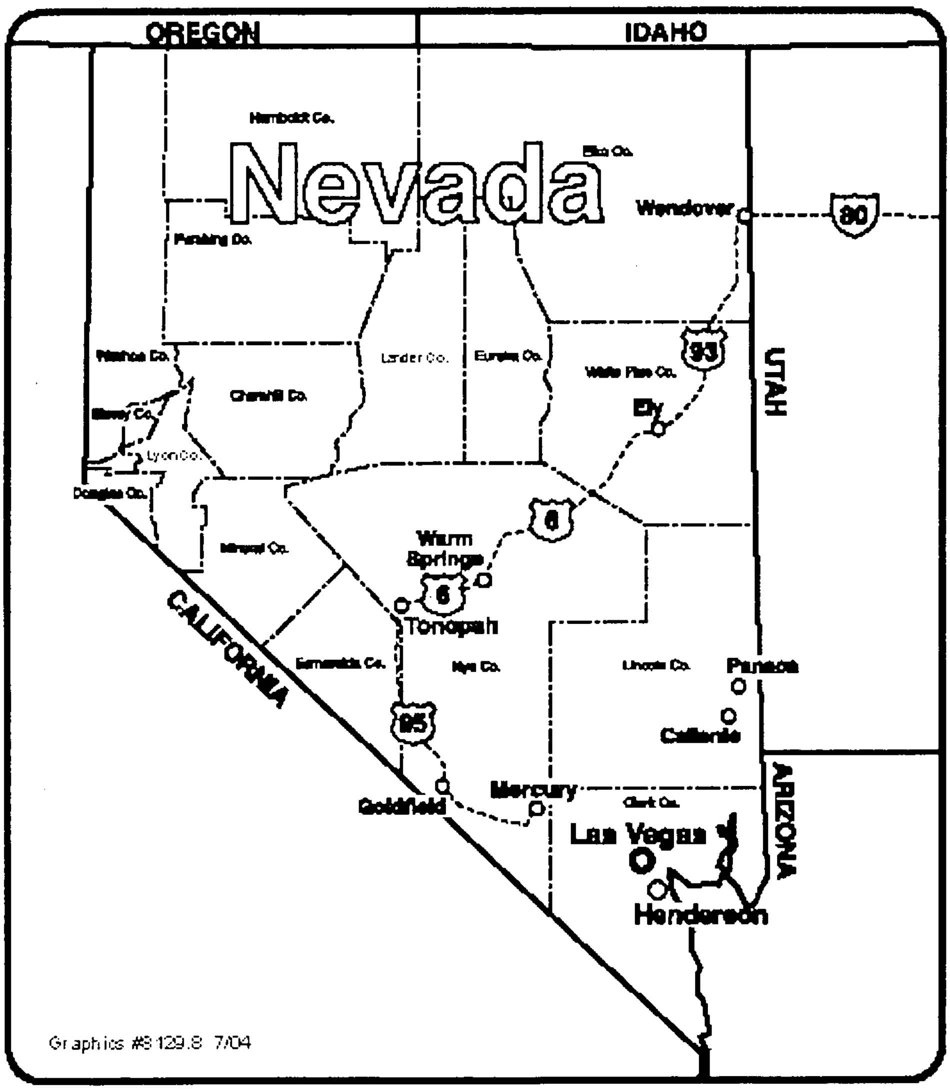
Northern Route
Travel south on Route 128 from the FCP and take I-74 west to I-465 to I-70 West at Indianapolis. Take I-70 west to I-25 north to I-80. Take I-80 west to Alternate US 93, south to US 93. At Ely, NV, take US 6 to Tonopah, NV. At Tonopah, NV, take US 95 to the NTS Mercury Gate.

The Northern Route traverses the following states: Ohio, Indiana, Illinois, Missouri, Kansas, Colorado, Wyoming, Utah, and Nevada.

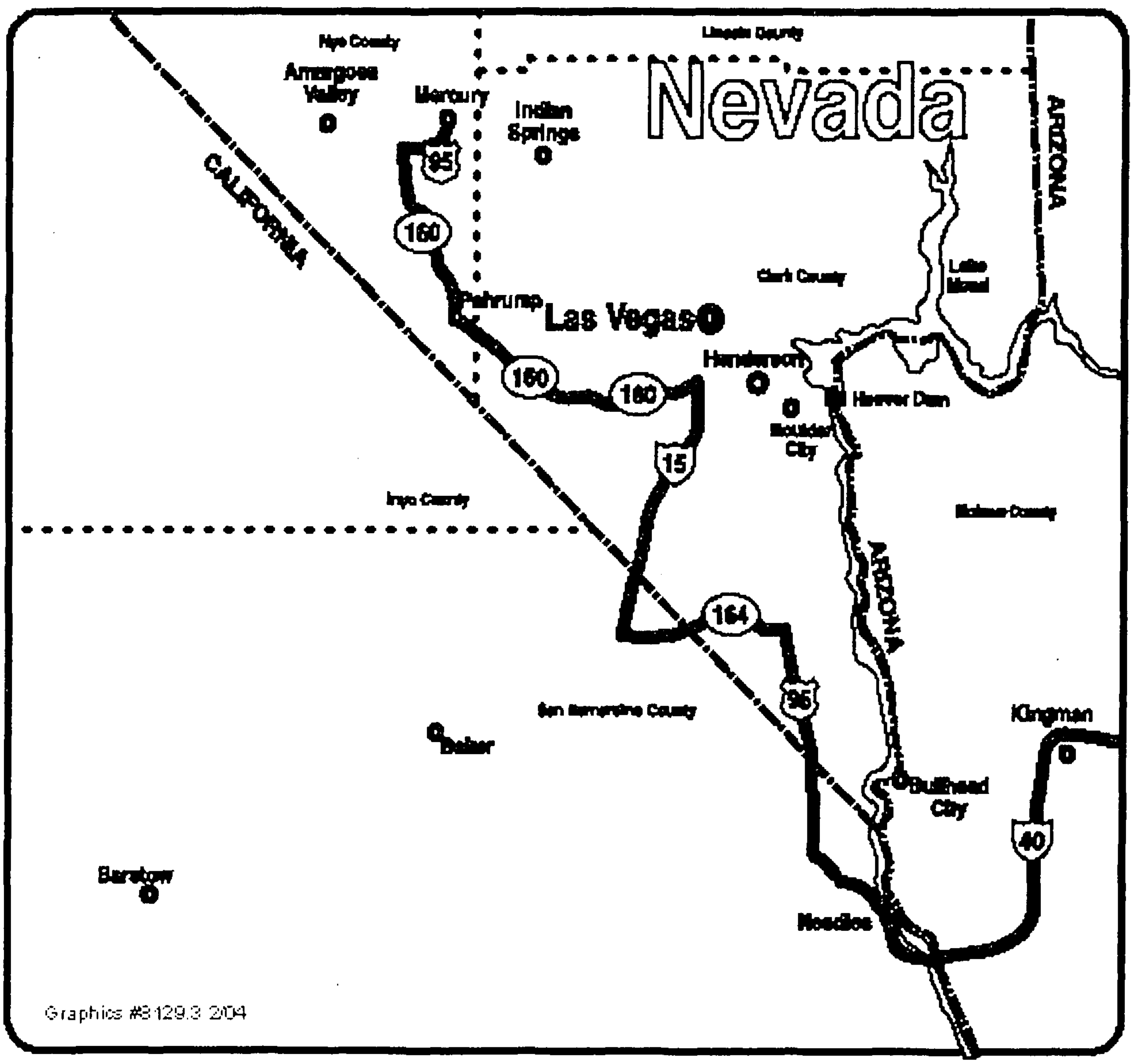
NORTHERN TRANSPORTATION ROUTE



Southern Route
Travel south on Route 128 from the FCP. Take I-74 west to I-275 west/south. Take I-275 to I-75 south to I-71 west to Louisville, KY. From Louisville, KY take I-64 west to St. Louis, MO. From St. Louis, MO follow I-44 to Oklahoma City, OK. Take I-40 through Kingman, AZ to Needles, CA. Proceed north on US 95 into Nevada. Go west on NV 164/Nipton Road to I-15. Proceed north on I-15 and west on Route 160 to Route 95. Take Route 95 east to Mercury, NV.

The Southern Route traverses the following states: Ohio, Kentucky, Indiana, Illinois, Missouri, Oklahoma, Texas, New Mexico, Arizona, California, and Nevada.

SOUTHERN ROUTE



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2.3.2 Risk and Safety Requirements

A transportation risk assessment has been conducted comparing the risks associated with truck transportation of chemically stabilized Silos 1 and 2 materials to the NTS, assuming transportation via flatbed truck. The assessment evaluated both potential risks associated with accident-free waste transportation (direct radiation) and the risks associated with an accident scenario. As documented in Appendix B, the calculated excess cancer risk to members of the general public for both scenarios meets the criteria specified by the Silos 1 and 2 ROD Amendment.

Per 49 CFR 397 Subpart D, Routing of Class 7 (Radioactive) Materials, the route selected for shipment of radioactive material to the NTS shall ensure that the radiological risk is minimized. Accident rates, transit time, population density and activities, and the time of day and week in which transportation will occur are included in the radiological risk determination.

2.3.3 Shipping Requirements

2.3.3.1 Department of Transportation Requirements

The FCP shall comply with applicable federal, tribal, state, and local regulations. Each package and shipment of hazardous materials for off-site shipment shall be prepared in compliance with 49 CFR 171-180, Hazardous Materials Regulations (HMR) and the applicable tribal, state, and local regulations.

2.3.3.2 Motor Carrier Selection

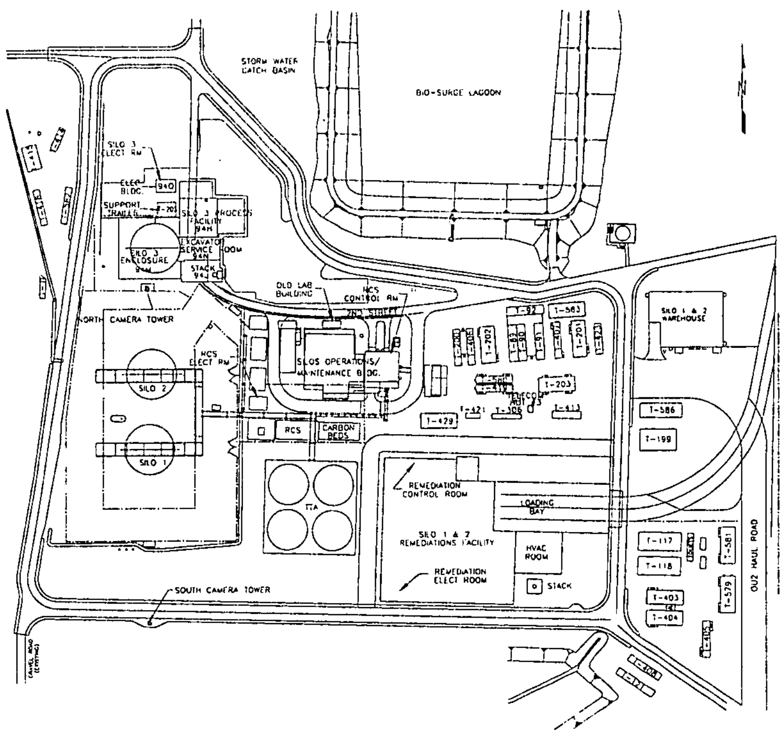
The FCP has awarded contracts for transportation of Silos 1 and 2 materials. All motor carriers selected for transport of the Silos 1 and 2 materials have been evaluated as part of the DOE MCEP.

3.0 ON-SITE WASTE MANAGEMENT

3.1 INTRODUCTION

This section addresses the on-site management of the Silos 1 and 2 materials, including the characterization, packaging, staging, inspections, and container movements. The following diagram is a representation of the layout of the Silos 1 and 2 Area:

FIGURE 3-1



3.2 WASTE CHARACTERIZATION

The Silos Project is responsible for characterizing the chemically stabilized Silos 1 and 2 materials to coordinate the appropriate waste disposal/storage, packaging and transportation options for this waste. To accomplish these tasks, the Waste Characterization (WC) group has reviewed project submittals, the regulatory status, process knowledge, and analytical data from the OU4 Remedial Investigation (RI) for Silos 1 and 2 wastes to properly characterize the materials. This characterization is documented in Material Evaluation File (MEF) 3706.

3.3 PACKAGING

Packaging of waste for shipment has been reviewed and approved by the Safety Review Committee (SRC). WC, Shipping, and the NTS Quality Control organization will do ongoing evaluation on a per-shipment basis. The Silos 1 and 2 wastes and packaging were evaluated for absorbent requirements and material and container compatibility. Based on the evaluation, absorbent addition is not required, and materials and container are compatible. The packaging and transport system configurations have been evaluated, tested, and approved. Customized trailers with engineered tie-downs will be utilized.

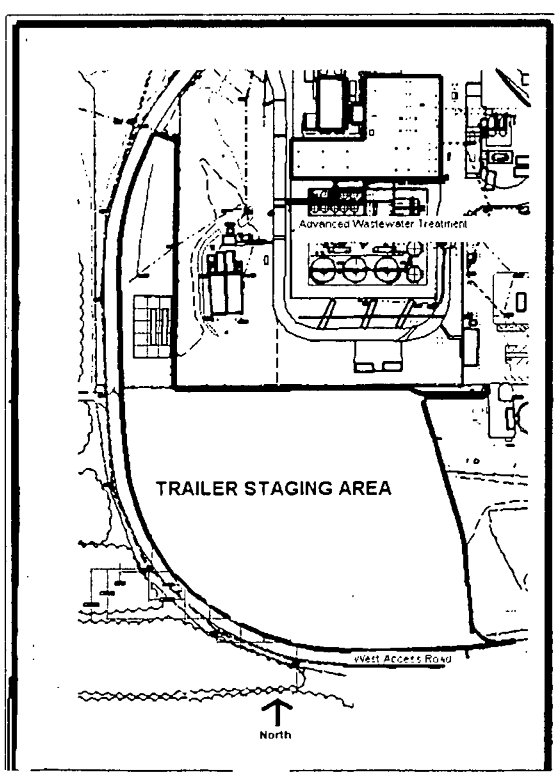
The current Silos 1 and 2 packaging approach assumes chemically stabilized Silos 1 and 2 materials are packaged in 196-ft3 Industrial Packaging - Type 2 (IP-2), 6-foot diameter, 6.5-foot height, half-inch thick cylindrical carbon steel containers, loaded onto flat bed trailers (two containers per trailer), and staged for shipment to the NTS.

The containers will be filled with Silos 1 and 2 materials, weighed, labeled, and surveyed before being placed onto the flatbed trailer for shipping to NTS. The treated waste form will be a low-strength grout with no free liquid present. When filled, each container will have a maximum weight of 21,950 pounds and an expected on-contact dose rate of up to 80 mrem/hour.

3.4 STAGING AND INSPECTIONS

Inbound trailers will be inspected and surveyed before being moved to the Trailer Staging Area (TSA), using a yard tractor. The TSA will serve as a place for staging of empty and loaded trailers, as well as repair of unfit trailers. Following is a diagram of the TSA:

FIGURE 3-2



The loading will be done inside the Silos 1 and 2 Remediation Facility. The flatbed trailer will be pulled into the facility and an overhead bridge crane will be utilized to load the containers. Once the packages are approved for disposal, loading of the trailers will be performed.

After the trailer is surveyed and released from the Silos area for shipment, the Shipping organization will prepare the remaining paperwork. Individual containers of Silos 1 and 2 materials will be tracked using the existing on-site waste tracking databases.

4.0 HEALTH AND SAFETY

4.1 INTRODUCTION

The focus of this section will be the Health and Safety approach for on-site transportation operations-related activities. The overall on-site project Health and Safety responsibility lies directly with the DOE, Fluor Fernald, and its contractors and is implemented according to PL-3081, Safety Management System Description, which incorporates the core functions of the Integrated Safety Management System (ISMS). The specific functional areas of safety addressed in this section are Nuclear and Systems Safety, Occupational Safety and Health, Radiological Protection, and Security.

4.2 NUCLEAR AND SYSTEMS SAFETY

The FCP Nuclear and System Safety Program is identified in RM-2116, System Safety Requirements and is implemented by Fluor Fernald through site procedures. Safety analyses are performed to help ensure the health and safety of the public, the workers, and the environment. A Nuclear Health and Safety Plan (NHASP) is being developed for operation of the Silos 1 and 2 Project and will be approved by DOE.

Safety analysis documentation is being developed for staging of material and motor vehicle shipping activities for Silos projects. All shipments and containers (including Silos 1 and 2 shipping containers) will comply with DOT regulations, which will help to ensure the health and safety of the public, the workers, and the environment.

4.3 OCCUPATIONAL SAFETY AND HEALTH

The FCP Occupational Safety and Health Program requirements are defined in the RM-0021, Safety Performance Requirements (SPR) Manual. The SPRs apply to activities at the FCP. SPRs identify requirements established by federal, state, and local regulations, in addition to requirements from DOE Orders and Best Management Practices established by Fluor Fernald through experience, lessons learned, and employee input. SPRs identify safety and health standards for assessing and planning work at the FCP. SPRs contain guidelines on what must be done to safely execute work and are not intended to specify how to execute work. The Fluor Fernald Silos 1 and 2 Project team will implement the SPRs by incorporating their requirements into any project-specific procedures and contracts that will be developed to guide the performance of transportation activities. Silos 1 and 2 material shipments will be performed in accordance with existing shipping procedures, which incorporate the required SPRs.

Project-specific safety and health requirements will be developed as the details of the project unfold. For planning purposes, however, existing SPRs are being used as the basis for health and safety on this project. The SPRs and additional project-specific safety requirements are incorporated into planning documents and implementing procedures.

4.4 SAFETY PRECAUTIONS

Staging of packaged Silos 1 and 2 materials will be in designated and approved area(s).

4.5 RADIOLOGICAL PROTECTION

Equipment and material, including containers of Silos 1 and 2 materials, will be released from the Silos 1 and 2 facility when the exterior of the item meets DOT surface contamination limits. Therefore, it is planned that shipment-preparation activities will take place in a Controlled Area. FCP Radiological Control Technicians (RCTs) will conduct routine radiological surveys to ensure contamination levels are maintained below Contamination Area limits. FCP Radiological Control will survey the exterior of each container for compliance with DOT regulations and Fluor Fernald Radiological Protection Program (RPP) requirements. Exterior non-fixed contamination levels will be determined per 49 CFR 173.443, Contamination Control for shipments and 10 CFR 835, Occupational Radiation Protection for staging. Once the containers have been surveyed and are ready for release, they will be loaded onto flatbed trailers. After the trailers have been surveyed and released, they will be transported to the TSA or other on-site staging location.

If the equipment or material in the Controlled Area exceeds Contamination Area levels, a Contamination Area will be established and a new Radiation Work Permit (RWP) will be issued. The RWP will define the level of anti-contamination clothing and RCT coverage required. If decontamination is feasible, decontaminating the work surface to a level below Contamination Area limits will eliminate the need for routine wearing of anti-contamination clothing and reduce the RCT coverage requirements. If/when Contamination Areas are established, whole body monitoring will be required for exiting the area. Immediately following the completion of work, the area will be decontaminated, as necessary, and surveyed for the purpose of down-posting.

Detailed project-specific radiological control requirements will be developed and incorporated into procedures and work permits.

Only necessary personnel with the appropriate training will be given access to the radiologically controlled areas. The crew will ingress/egress through a radiological control point(s) and will be subject to personal contamination monitoring upon exit. Incidents of personal contamination will be addressed per existing, approved site procedures.

In addition to the FCP radiation protection program, transportation contractors will be required to implement a personnel radiation protection program in accordance with 10CFR 20 to ensure that no driver exceeds the 5000mrem (5rem) annual dose limit.

4.6 SECURITY

Areas where Silos 1 and 2 materials will be loaded and staged pending the completion of shipment will be within the site fence and provided with the appropriate levels of security and lighting. FCP Security monitors site access by using stationary posts and conducting walking, driving, and perimeter patrols on a 24-hour basis.

5.0 EMERGENCY RESPONSE

5.1 INTRODUCTION

This section documents the emergency response procedures that are in place to respond to transportation accidents involving shipments of Silos 1 and 2 materials. The scope of this discussion focuses on off-site occurrences and references procedures for on-site occurrences.

DOE Order 151.1, Comprehensive Emergency Management, provides for a DOE Emergency Management System (EMS). Pursuant to this order, DOE must maintain a Transportation Emergency Preparedness Program (TEPP) that enhances and integrates transportation emergency preparedness capabilities within the EMS. The TEPP has been established at DOE headquarters. The FCP has a similar program. The TEPP ensures that an adequate DOE response to transportation incidents involving DOE materials is performed and that DOE's responsibilities under the National Contingency Plan (NCP) and the Federal Radiological Emergency Response Plan are adequate. The Transportation Emergency Preparedness Program also provides technical advice and assistance as required for transportation incidents involving radioactive wastes.

DOE Order 435.1, Radioactive Waste Management and associated manual DOE M 435. 1-1, Chapter IV, Section L.2, Transportation, also state that the volume of waste and number of waste shipments shall be minimized to the extent practical. This requirement was considered in development of the Silos 1 and 2 waste form and associated transportation planning.

5.2 FCP EMERGENCY RESPONSE PREPAREDNESS PLANS

The FCP Transportation Emergency Plan (TEP), PL-3043, is part of the DOE-FCP Transportation Emergency Preparedness Program. The FCP TEP provides a centralized program approach to off-site transportation emergency response including products, samples, and waste shipments.

The FCP TEP describes the overall DOE/FCP process developed for the coordination of response efforts to off-site transportation incidents. This assistance planning is accomplished by adherence to applicable federal, state, and local transportation-related emergency response requirements, plus utilizing existing DOE programs designed to protect the well-being of citizens and the environment from accidental release of transported materials.

Procedures for on-site emergencies are addressed in PL-3020, FCP Emergency Plan, which details the procedures to be followed at the FCP in the event of an accident or emergency, highlights FCP safety features, and governs the spill response actions. The FCP Emergency Plan is distributed to participating mutual aid organizations, such as local fire departments and hospitals, in the general vicinity of the FCP. Additionally, PL-2194, the FCP Spill Prevention Control and Countermeasure Plan will be implemented accordingly for incidents on, or in close proximity to, the FCP. Silos-specific emergency procedures are addressed in EM-0030, Silos Area Emergency Procedure.

5.3 EMERGENCY RESPONSE FOR THE FCP OFF-SITE SHIPMENTS

A Silos 1 and 2 material shipment will become an off-site shipment at the point when the entire shipment crosses the facility boundary. When the shipment is off-site, the motor carrier will be responsible for providing emergency response support to the local authorities in proximity of any incident. The carrier also will have contractors available for containment and cleanup as necessary. The FCP will provide technical assistance via the 24-hour emergency response telephone number. DOE will advise and provide support as requested by the local response authority (49 CFR 174.750). Local response personnel including police, firefighters, and emergency responders, typically are the first to arrive on the scene of an incident. They must be provided with the technical information needed by first responders to accurately identify the hazards involved in the incident. Information contained in the shipping papers includes source terms, health and safety concerns, and recommended protective actions. The information is consistent with the DOT, Research and Special Programs Administration (RSPA) publication, North American Emergency Response Guidebook, Guide 162.

Consistent with the procedure for other shipments to the NTS, advance notification will be provided to state and tribal emergency response organizations prior to the beginning of the Silo 1 and 2 shipping campaign. The notification will include information such as the number of shipments, the type of material and packaging configuration, the projected dates for initiation and completion of shipments, and on-site contact information. Primarily for security reasons, current policy for waste shipments does not provide for notification of the date, time, and route of individual Silo 1 and 2 waste shipments.

The following is an overview of the emergency response responsibilities of the motor carriers, DOE, individual states, and the FCP to support local authorities at an accident scene.

1. Carriers
   - Trained in accordance with DOT Emergency Response Guidebook and the carrier's respective Emergency Response Plans
   - Stabilize situation
   - Provide notification of incident to carrier home office
   - Provide notification to FCP/DOE

2. Carrier Emergency Response Organization
   - Make appropriate additional notification (local authorities, DOE, etc.)
   - Dispatch Emergency Response Personnel to the scene to support On-Scene Commander
   - Mobilize strategically positioned emergency response subcontractors, if necessary
   - Responsible for Recovery Actions

3. Local Authorities
   - Typically function as the On-Scene Commander

4. State Emergency Response Organizations
   - Each state possesses an Emergency Response Organization capable of responding to radiological emergencies

5. DOE Regional Radiological Assistance Teams
   - Eight Radiological Assistance Teams across the United States
   - Provide On-Scene Commanders with support in terms of radiological monitoring, communications, and information coordination during an emergency
   - Consist of DOE and contracted personnel possessing expertise in health physics, public information, and communications

The FCP TEP is activated when the carrier or the local response organizations contacts the FCP to notify DOE that an incident has occurred. The 24-hour emergency phone number provided on the bill of lading, as required by 49 CFR 172.604, Emergency Response Telephone Number, is a direct telephone line to the FCP Communications Center.

The FCP Communications Center provides communication capability for the FCP, monitors conditions, and makes notifications as required. The FCP Communication Center establishes and maintains direct communication with the On-Scene Commander and the FCP Assistant Emergency Duty Officer (AEDO) until the Emergency Operations Center (EOC) is activated.

The FCP EOC is activated at the direction of the AEDO or Emergency Duty Officer (EDO) for events categorized at the emergency level, including transportation events and for non-emergency events at the discretion of the EDO. The EOC officially becomes operational when the Emergency Director or Deputy Emergency Director arrives at the EOC, determines that sufficient personnel are available to manage the response, and declares the EOC operational. The combined efforts of EOC staff members provide support, guidance, and direction to the On-Scene Commander in the field. The EOC staff assumes responsibilities such as making protective action recommendations, providing notifications, and obtaining necessary resources, as required by the specific circumstances of the event.

Motor carriers maintain Emergency Response Plans (ERP), which outline the procedures the carrier's employees must take in the event of an incident. The plan includes notification responsibilities, emergency response procedures for personnel on the scene, environmental considerations, and additional precautions to take in the event of an incident. DOE, as the shipper, will be notified by the carrier immediately should an incident occur. Both the carrier and DOE will initiate emergency procedures upon notification.

6.0 WASTE DISPOSAL

6.1 INTRODUCTION

This section discusses disposal of Silos 1 and 2 materials at the NTS and the related regulatory and waste acceptance information.

6.2 SILOS 1 AND 2 MATERIALS QUANTITIES/CHARACTERISTICS

Silos 1 and 2 contain approximately 8,890 cubic yards of residues from uranium extraction operations at the Mallinckrodt Chemical Works and the FCP in the 1950s. Samples collected from Silos 1 and 2 indicate the presence of significant activity and concentrations of the radionuclides within the uranium decay series, confirming prior process knowledge. The predominant radionuclide of concern identified within Silos 1 and 2 is Ra226. Approximately 3,770 curies of Ra226 are distributed within the Silos 1 and 2 materials. (Note: The 3,770 curies is a mean inventory value. The 95% upper confidence limit inventory value is approximately 4,740 curies. For most determinations, the upper confidence limit values are used for conservatism.)

Since the time that DOE assumed ownership of the material in 1984, the Silos 1 and 2 materials have been classified as by-product material under Section 11e.(2) of the Atomic Energy Act (AEA), of 1954, as amended. This classification arises from the origin of the material, as "residue from the extraction or concentration of uranium from ores processed primarily for their source material content." The basis for DOE's classification of the Silos 1 and 2 material as 11e.(2) by-product material, and for DOE's plan to dispose of the material at the NTS, was documented in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Environmental Policy Act (NEPA), subjected to formal public and state review in both Ohio and Nevada, and approved by the DOE and U.S. EPA in the original Final Record of Decision for Operable Unit 4 Remedial Action in December 1994.

Due to its classification as 11e.(2) by-product material, the Silos 1 and 2 materials are specifically exempt, as defined, from regulation as solid or hazardous waste under the RCRA, 40 CFR 261.4(a)(4), Identification and Listing of Hazardous Waste, Exclusions. Although RCRA is not applicable, certain RCRA requirements (container management, tank standards, etc.) were adopted by the OU4 ROD as relevant and appropriate to on-site (i.e., at the FCP) management of the Silos 1 and 2 materials.

The current remedy specifies chemical stabilization of the Silos 1 and 2 materials prior to disposal. The chemical stabilization process results in a significant volume increase, in exchange for elimination of free liquid and reduced mobility (leachability) of lead.

6.3 DISPOSAL OF SILOS 1 AND 2 MATERIALS

At this time, the NTS is the only viable option for disposing of chemically stabilized Silos 1 and 2 materials. The current revision (Revision 5) of the NTS WAC allows management and disposal of untreated Silos 1 and 2 materials at the NTS as 11e.(2) material.

Silos 1 and 2 materials will be shipped and disposed after chemical stabilization. Radionuclide concentrations, as well as other parameters of interest, will be determined to ensure the chemically stabilized material offered for disposal meets the NTS WAC. Only material that meets the disposal facility WAC will be accepted for transportation and disposal under this plan.

Once the Silos 1 and 2 Project receives verification that the material meets the disposal facility WAC and the trucks carrying the material have been surveyed and approved for release, the Silos 1 and 2 materials will be released for shipment from the FCP.

6.3.1 Regulatory Information

The DOE, Nevada Operations Office, and Nevada Test Site Waste Acceptance Criteria (NTSWAC) establish the requirements for disposition of waste at the NTS. Additionally, the NTSWAC, DOE/NV-325, Revision 5, requires that packaging and shipments to the NTS be performed in accordance with DOE Order 435.1, "Radioactive Waste Management", 40 CFR, and 49 CFR.

6.3.2 NTS Waste Acceptance

DOE/Nevada Operations Office requires that prior to generator approval to ship waste to the NTS, they must develop a certification program to ensure waste is compliant with the requirements of the NTSWAC. The process used by DOE/Nevada Operations Office for approval of a generator's certification program includes program reviews and evaluations of implementation at the generator's facility.

Once the generator has an approved program, a waste profile must be developed and submitted for each waste stream that is shipped for burial at the NTS. These profiles provide the NTS with an understanding of the characterization and quantities of the material. The characterization of Silos 1 and 2 material was submitted for NTS review in Profile ONLO-000000132.

Before being approved for disposal, profiles for new waste streams are reviewed to ensure that the proposed waste form and disposal configuration will meet all of the performance standards specified by the performance assessment conducted in accordance with DOE Order 435.1. If the profiles as stated are approved, the generator is then notified in writing of the authorization and packaging and shipment may commence. Approval of the profile for Silos 1 and 2 material was issued by DOE-Nevada on April 2, 2004.

The FCP's Waste Certification Official and designees, in accordance with the Waste Certification Program Plan, PL-3067, will provide oversight of any packaging and shipping operations that are performed to ensure and document that requirements have been met for waste disposal at the NTS. If requirements are met, then the waste packages, the documentation packages, and the transport vehicles are "certified" in accordance with the NTSWAC and Fluor Fernald requirements and released for transport to the NTS.

6.3.3 Receipt of Waste at the NTS

Once the waste generator has received approval to ship and has performed certification activities to release shipments for disposal, the generator must notify the NTS Manager to arrange for transfer of the waste and accompanying records.

Prior to shipment, certain records must be sent electronically. Pre-notification information includes time of departure, estimated time of arrival; carrier, trailer, and security seal numbers; description of load; waste type; and a copy of the Package Storage and Disposal Request.

Once the shipment arrives at the NTS (Mercury location), the driver must provide a copy of the completed proper shipping papers with shippers certification, original Package Storage Disposal Request, and an appropriate Waste Certification Statement signed by the Waste Certification Official or an alternate designee (Alternate Waste Certification Official). Once these documents are reviewed and accepted, the shipment may be unloaded at the disposal location.

The NTS proposes to dispose of the containers of treated Silos 1 and 2 materials in Area 5.

7.0 REFERENCES

Code of Federal Regulations, 10 CFR 835,"Occupational Radiation Protection"

Code of Federal Regulations, 10 CFR Chapter 1,"Nuclear Regulatory Commission"

Code of Federal Regulations, 40 CFR 261.4, "Identification and Listing of Hazardous Waste, Exclusions"

Code of Federal Regulations, 40 CFR 300, "National Oil and Hazardous Substances Pollution Contingency Plan"

Code of Federal Regulations, 41 CFR 101-40, "Transportation and Traffic Management"

Code of Federal Regulations, 49 CFR 171-180, "Hazardous Materials Regulations"

Code of Federal Regulations, 49 CFR 107, "Hazardous Materials Program Procedures"

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U.S. Department of Energy, 1984, "Radioactive Waste Management," DOE-435.1

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U.S. Department of Energy, 1999, "Radioactive Waste Management," DOE-435.1, July 1999

U.S. Department of Energy, 2003, "Safety Basis Requirements," 10 CFR 830, Subpart B, January 2003

U.S. Department of Energy, 2004, "Approval to Ship Fernald Closure Project (FCP) Low-Level Radioactive Waste to the Nevada Test Site," Carl P. Gertz to William J. Taylor, April 2, 2004

APPENDIX A
SILOS 1& 2 MATERIAL LSA DETERMINATION (HM-230, EFF. OCTOBER 1, 2004)

APPENDIX A
SILOS 1& 2 MATERIAL LSA DETERMINATION (HM-230, EFF. OCTOBER 1, 2004)

Table A-1 below represents the source term for the Silos 1 and 2 materials, as well as the LSA classification and packaging determinations.

Column 1 identifies each radionuclide present in the Silos 1 and 2 materials.

Columns 2 and 4 identify the activity concentration for each radionuclide in terabecquerels per gram (TBq/g) and becquerels per gram (Bq/g), respectively. Columns 3 and 5 identify the total activity of each radionuclide in terabecquerels (TBq) and becquerels (Bq), respectively. The values in Columns 3 and 5 were arrived at by taking the activity concentration per radionuclide multiplied by the net weight in grams of material.

The radionuclide specific limits shown in Columns 6 and 8 are prescribed by 49 CFR 173.436. 49 CFR 173.436 Footnote (b) specifies the progeny that have been taken into consideration when assigning the activity concentration and consignment limits of the parent. The table provides a list of these parent/progeny relationships included in Silos 1 and 2 materials.

Column 7 contains the result of the unity calculation per nuclide for the activity concentration limit for exempt material (ACEM) and is derived by the following:
Column 4, "Activity Concentration (Bq/g)" divided by Column 6, "ACEM [Activity Concentration Limit for Exempt Material] (Bq/g)"

Column 9 contains the result of the unity calculation per nuclide for the activity limit for exempt consignment (ALEC) and is derived by the following:
Column 5, "Total Activity (Bq)" divided by Column 8, "ALEC [Activity Limit for Exempt Consignment] (Bq)"

If the sum of either column is less than or equal to 1, then the material is not regulated as Class 7 radioactive material. As demonstrated in the table, the sum of each unity calculation individually exceeds 1; therefore, the Silos 1 and 2 material meets the definition of Class 7 radioactive material.

Column 10 identifies the applicable LSA-I limit, which is 30 times the ACEM. Column 11 contains the result of the unity calculation per nuclide for LSA-I and is derived by the following:
Column 4, "Activity Concentration (Bq/g)" divided by Column 10, "LSA-I(1)(iv) 30x Activity Concentration Limit (Bq/g)"

If the sum of Column 11 exceeds 1, then the radioactive material cannot be shipped as LSA-I material. As shown in the table, the LSA-I unity calculation greatly exceeds 1; therefore, it does not meet the definition of LSA-I.

Column 14 identifies the A2 values prescribed by 49 CFR 173.435. 49 CFR 173.435, Footnote (a), indicates that certain A2 values already include the contributions from daughter nuclides with half-lives less than 10 days and considered to be in secular equilibrium with their parent nuclide. The table provides a list of these parent/daughter relationships included in Silos 1 and 2 materials.

The definition of LSA-II solid material found at 173.403 *LSA material* requires that the activity is distributed throughout and the average specific activity of the material is less than 10^{-4} A_2/g. This limit is identified in Column 12. Column 13 contains the result of the unity calculation per nuclide for LSA-II and is derived by the following:
Column 2, "Activity Concentration (TBq/g)" divided by Column 12, "LSA-II (2)(ii) Limits 10^{-4} A2/g"

If the sum of Column13 exceeds 1, then the radioactive material cannot be shipped as LSA-II material. As shown in the table, the sum of the LSA-II unity calculation does not exceed 1; therefore, it can be classified and shipped as LSA-II material. At this point, it has been determined the Silos 1 and 2 material meets the DOT definitions of radioactive and LSA-II material.

Column 15 contains the result of the A2 unity calculation per nuclide and is derived by the following:
Column 3, "Total Activity (TBq)" divided by Column 14, "A2 Limits (TBq)"

If the sum of Column 15 exceeds 1, thereby exceeding an A2 quantity, the material cannot be shipped in an excepted package as permitted by 173.427(b)(4). As shown in the table, the sum of the A2 unity exceeds 1; therefore, the Silos 1 and 2 material must and will be packaged in a Type IP-2 packaging, subject to the limitations of Table 6, as required by 49 CFR 173.427 (b)(1). Per Table 5, the activity limit for the conveyance is unlimited for LSA-II Non-combustible Solids.

TABLE A-1

Project: Silos 1 & 2 Transportation & Disposal Plan - Appendix A
Container: Non-Bulk IP-2
Weight/Unit: 19000 Lbs.
Net Weight: 19000.0 Lbs. Net Wt (Gms): 8,618,210.0

					49 CFR 173.436 [HM-230]				49 CFR 173.403 [HM-230]				49 CFR 173.435 [HM-230]	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Radionuclide	Activity Concentration (TBq/g)	Total Activity (TBq)	Activity Concentration (Bq/g)	Total Activity (Bq)	ACEM [Activity Concentration Limit for Exempt Material] (Bq/g)	ACEM Unity	ALEC [Activity Limit for Exempt Consignment] (Bq)	ALEC Unity	LSA-I (1)(iv) 30X Activity Concentration Limit (Bq/g)	LSA-I Unity	LSA-II (2)(ii) Limits 10^{-4} A2/g	LSA-II Unity	A2 Limits (TBq)	A2 Unity
Ac-227	5.809E-11	5.006E-04	5.809E+01	5.006E+08	1.000E-01	5.809E+02	1.000E+03	5.006E+05	3.000E+00	1.936E+01	9.000E-09	6.454E-03	9.000E-05	5.563E+00
Ac-228	4.736E-12	4.082E-05	4.736E+00	4.082E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Bi-210	3.134E-09	2.701E-02	3.134E+03	2.701E+10	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Bi-211	5.809E-11	5.006E-04	5.809E+01	5.006E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Bi-212	4.736E-12	4.082E-05	4.736E+00	4.082E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Bi-214	3.134E-09	2.701E-02	3.134E+03	2.701E+10	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Fr-223	8.029E-13	6.920E-06	8.029E-01	6.920E+06	1.000E+01	8.029E-02	1.000E+04	6.920E+02	3.000E+02	2.676E-03	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Pa-231	5.809E-11	5.006E-04	5.809E+01	5.006E+08	1.000E+00	5.809E+01	1.000E+03	5.006E+05	3.000E+01	1.936E+00	4.000E-08	1.452E-03	4.000E-04	1.252E+00
Pa-234m	3.156E-12	2.720E-05	3.156E+00	2.720E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Pb-210	3.134E-09	2.701E-02	3.134E+03	2.701E+10	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	5.000E-06	6.268E-04	5.000E-02	5.402E-01
Pb-211	5.809E-11	5.006E-04	5.809E+01	5.006E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Pb-212	4.736E-12	4.082E-05	4.736E+00	4.082E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Pb-214	3.134E-09	2.701E-02	3.134E+03	2.701E+10	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-210	3.134E-09	2.701E-02	3.134E+03	2.701E+10	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	2.000E-06	1.567E-03	2.000E-02	1.350E+00
Po-211	1.587E-13	1.368E-06	1.587E-01	1.368E+06	1.000E-01	1.587E+00	1.000E+03	1.368E+03	3.000E+00	5.291E-02	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-212	3.034E-12	2.615E-05	3.034E+00	2.615E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-214	3.134E-09	2.701E-02	3.134E+03	2.701E+10	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-215	5.809E-11	5.006E-04	5.809E+01	5.006E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-216	4.736E-12	4.082E-05	4.736E+00	4.082E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Po-218	3.134E-09	2.701E-02	3.134E+03	2.701E+10	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Ra-223	5.809E-11	5.006E-04	5.809E+01	5.006E+08	1.000E+02	5.809E-01	1.000E+05	5.006E+03	3.000E+03	1.936E-02	7.000E-07	8.299E-05	7.000E-03	7.152E-02
Ra-224	4.736E-12	4.082E-05	4.736E+00	4.082E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Ra-226	3.134E-09	2.701E-02	3.134E+03	2.701E+10	1.000E+01	3.134E+02	1.000E+04	2.701E+06	3.000E+02	1.045E+01	3.000E-07	1.045E-02	3.000E-03	9.003E+00
Ra-228	4.736E-12	4.082E-05	4.736E+00	4.082E+07	1.000E+01	4.736E-01	1.000E+05	4.082E+02	3.000E+02	1.579E-02	2.000E-06	2.368E-06	2.000E-02	2.041E-03
Rn-219	5.809E-11	5.006E-04	5.809E+01	5.006E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Rn-220	4.736E-12	4.082E-05	4.736E+00	4.082E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Rn-222	3.134E-09	2.701E-02	3.134E+03	2.701E+10	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Th-227	5.809E-11	5.006E-04	5.809E+01	5.006E+08	1.000E+01	5.809E+00	1.000E+04	5.006E+04	3.000E+02	1.936E-01	5.000E-07	1.162E-04	5.000E-03	1.001E-01
Th-228	4.736E-12	4.082E-05	4.736E+00	4.082E+07	1.000E+00	4.736E+00	1.000E+04	4.082E+03	3.000E+01	1.579E-01	1.000E-07	4.736E-05	1.000E-03	4.082E-02
Th-230	4.662E-10	4.018E-03	4.662E+02	4.016E+09	1.000E+00	4.662E+02	1.000E+04	4.018E+05	3.000E+01	1.554E+01	1.000E-07	4.662E-03	1.000E-03	4.018E+00
Th-231	1.443E-13	1.244E-06	1.443E-01	1.244E+06	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Th-232	4.736E-12	4.082E-05	4.736E+00	4.082E+07	1.000E+01	4.736E-01	1.000E+04	4.082E+03	3.000E+02	1.579E-02	Unlimited	0.000E+00	Unlimited	0.000E+00
Th-234	3.156E-12	2.720E-05	3.156E+00	2.720E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	3.000E-05	1.052E-07	3.000E-01	9.067E-05
Tl-207	5.809E-11	5.006E-04	5.809E+01	5.006E+08	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
Tl-208	1.706E-12	1.470E-05	1.706E+00	1.470E+07	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(b) - Progeny	0.000E+00	(a) - Daughter	0.000E+00	(a) - Daughter	0.000E+00
U-234	3.156E-12	2.720E-05	3.156E+00	2.720E+07	1.000E+01	3.156E-01	1.000E+05	2.720E+02	3.000E+02	1.052E-02	6.000E-07	5.260E-06	6.000E-03	4.533E-03
U-235	1.443E-13	1.244E-06	1.443E-01	1.244E+06	1.000E+01	1.443E-02	1.000E+04	1.244E+02	3.000E+02	4.810E-04	Unlimited	0.000E+00	Unlimited	0.000E+00
U-238	3.156E-12	2.720E-05	3.156E+00	2.720E+07	1.000E+01	3.156E-01	1.000E+04	2.720E+03	3.000E+02	1.052E-02	Unlimited	0.000E+00	Unlimited	0.000E+00
TOTALS						1.433E+03		4.173E+06		4.777E+01		2.546E-02		2.194E+01
RESULTS					RADIOACTIVE ? (T/F): TRUE				Not LSA-I		LSA-II		>A2	

173.436, Footnote (b) - Parent nuclides and their progeny included in secular equilibrium are listed in the following:	
Parent	Progeny
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Tl-207
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Pb-210, Bi-210, Po-210
Ra-228	Ac-228
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
U-235	Th-231
U238	Th-234, Pa-234m

173.435, Footnote (a) - A_2 values include contributions from daughter nuclides with half-lives less than 10 days.:	
Parent	Daughter
Ac-227	Fr-223
Ra-223	Rn-219, Po-215, Pb-211, Bi-211, Po-211, Tl-207
Ra-226	Rn-222, Po-218, Pb-214, Bi-214, Po-214, Bi-210
Ra-228	Ac-228
Th-228	Ra-224, Rn-220, Po-216, Pb-212, Bi-212, Tl-208, Po-212
Th-234	Pa-234m
U-235	Th-231

APPENDIX B
TRANSPORTATION RISK EVALUATION
FOR SILOS 1 AND 2 REMEDIAL ACTION

APPENDIX B
TRANSPORTATION RISK EVALUATION FOR SILOS 1 AND 2 REMEDIAL ACTION

As supporting backup for the Silos 1 and 2 Transportation and Disposal Plan, this attachment provides an evaluation of the short-term radiological risks accompanying the transportation of Silos 1 and 2 materials from the FCP to the NTS.

OBJECTIVES AND APPROACH

The transportation risks were evaluated to permit a technical comparison of the proposed shipping routes for transporting Silos 1 and 2 materials to the NTS.

The radiological risks to the public and workers during transportation were calculated using the RADTRAN5 computer model and code developed by Sandia National Laboratories. RADTRAN5 estimates radiation doses to populations from routine (accident-free) transportation, dose risk from potential transportation accidents, and maximum exposed individual dose estimates. Calculation of accident-free population dose considers persons residing adjacent to the route, persons in vehicles sharing the route, and persons at stops. Potential dose risks are also calculated for populations that are downwind from hypothetical releases associated with accidents of varying severity. Dose risk from an accident includes the conditional probability of an accident of a particular severity. The population dose risk units are reported in person-rem.

To permit a fair comparison of the three proposed routes, the mode of transportation was assumed to be direct truck shipments from the FCP to the NTS by truck shipment either a northern route or southern route. For all the evaluations, a detailed discussion of the model input parameters, key assumptions, and the model outputs that in turn support the short-term risk assessment findings in this Transportation and Disposal Plan.

KEY ASSUMPTIONS FOR THE MODEL

This section summarizes the model assumptions and inputs based on the Silos 1 and 2 design concepts, coupled with regulatory-based and weight-based transportation requirements for safe waste transport.

It was assumed that the Silos 1 and 2 materials would be chemically stabilized and then loaded into steel, cylindrical containers. The containers will be approximately 6-ft in height by 6-ft in diameter with a wall thickness of approximately 1/2-inch. Two containers would be loaded on a flatbed trailer.

Based on the chemically stabilized waste volume, the currently approved remedy will require an estimated 7000 containers. With two containers per truck, 3500 truck shipments will be required to transport the Silos 1 and 2 materials to the NTS.

Proposed Transportation Routes

Southern Route to NTS. The preferred truck route to NTS consists of traveling State Route (SR) 128 in Ohio to the Interstate (I)-74 interchange then heading west on I-74 to I-275 west/south to I-75 and I-71 south. Trucks would then travel south on I-71 to the I-64 interchange in Louisville, Kentucky. Trucks would then travel on I-64 through western Indiana and Illinois to the I-44 interchange in St. Louis, Missouri. Trucks would then continue on I-44 to the I-40 interchange in Oklahoma City, Oklahoma. Shipments would travel west on I-40 through Oklahoma, Texas, New Mexico and Arizona into Needles, California. Shipments would then proceed north on United States (US) 95 into Nevada, to west on Nevada State Route 164 to Nipton Road in California to I-15. Shipments would then proceed north on I-15 to west on Nevada State Route 160 to east on US95 to the NTS.

This route would pass through the following major cities: Louisville, Kentucky; St. Louis Missouri; Oklahoma City, Oklahoma; Tulsa, Oklahoma; Santa Fe, New Mexico, and the outskirts of Las Vegas, Nevada. Truck routes would use interstate bypasses, where such bypasses exist.

Northern Route to NTS. The northern truck route to the NTS consists of traveling State Route (SR) 128 in Ohio to the I-74 interchange then heading northwest on I-74 to the I-70 interchange in Indianapolis, Indiana. Trucks would then travel on I-70 through western Indiana and Illinois to the I-270 bypass north of St. Louis, Missouri. Trucks would then continue on I-70 through Missouri, Kansas, and into Colorado. In Colorado, shipments would take I-70 to I-270, avoiding Denver, to west on I-76 to north on I-25 to the I-80 interchange just west of Lincoln, Nebraska. Trucks would then continue on I-80 west through Nebraska, Wyoming, Utah, into Nevada. In Nevada, trucks would continue on I-80 to south on Alternate US93 to US6 to Tonopah, Nevada. In Tonopah, shipments would take US95 to the NTS.

This route would pass through the following major cities: Indianapolis, Indiana; St. Louis Missouri; Kansas City, Missouri; Cheyenne, Wyoming; and Salt Lake City, Utah. Truck routes would use interstate bypasses, where such bypasses exist.

RISK EVALUATION - MODEL INPUTS

The DOT requires carriers to utilize routes that minimize radiological risk when transporting radioactive material (DOT Class 7 hazardous material). When determining radiological risk, the DOT regulation 49 Code of Federal Regulation (CFR) Part 397.101(a)(2) requires the carrier to consider available information, such as, accident rates, population densities, and transit time.

RADTRAN5 relies on various parameters, which are defined by the user, for calculating dose. This information relates to the radioactive material, the package, the vehicle, and the route. It includes parameters for the number of shipments, the number of containers per shipment, the radionuclide content of the container, the radiation dose associated with the container, and the radiation dose associated with the shipment. Table B-1 presents the user-defined package-specific and vehicle-specific parameters associated with the proposed transportation routes. Where possible, "standard" RADTRAN5 values for parameters were used if they were not specific to the radioactive material, package, vehicle, or route.

TABLE B-1
PACKAGE-SPECIFIC AND VEHICLE-SPECIFIC PARAMETERS FOR RADTRAN5 ANALYSIS

PARAMETER	TRUCK SHIPMENTS NORTHERN & SOUTHERN ROUTES
Number of Shipments	3500
Number of Containers per Shipment	2
Characteristic Package Dimension (m)	1.90
Dose Rate 1 m from Vehicle (mrem/hr)	28.96
Characteristic Vehicle Dimension (m)	7.08
Number of Crew Members	2
Average Distance from Package to Crew Members (m)	7.0
Crew View Package Dimension (m)	1.92

Table B-2 presents the radionuclide input parameters for RADTRAN5. For purposes of the modeling, the radionuclide chains were broken down into sub-chains of the main radionuclides: Ac-227, Pa-231, Pb210, Ra-226, Th-228, Th-230, U-235, and U-238. Table B-3 then provides the radionuclide content per steel, cylindrical container. As stated previously, it is assumed that two steel, cylindrical containers will be placed on a flatbed truck.

TABLE B-2
RADIONUCLIDE PARAMETERS

Radionuclide	U-238	U-235	Th-232	Th-230	Ac-227	Ra-226	Pa-231	Pb-210
Half-life (days)	1.63E+12	2.57E+11	5.11E+12	2.81E+07	7.95E+03	5.84E+05	1.20E+07	8.14E+03
Photon Energy (meV/dis)	2.37E-02	2.69E-02	2.68E+00	1.55E-03	4.27E-01	1.72E+00	1.50E-02	4.81E-03
Cloud Shine DCF (rem-m^3/Ci-sec)	3.17E-03	2.62E-02	4.18E-01	6.44E-05	5.41E-02	2.98E-01	4.70E-03	2.13E-04
Ground Shine DCF (rem-m^2/Ci-sec)	9.56E-06	5.33E-05	7.27E-04	2.40E-07	1.24E-04	4.44E-04	1.30E-05	1.13E-06
CEDE Inhalation DCF (rem/Ci)	2.51E+08	1.23E+08	7.91E+08	2.85E+08	6.61E+08	1.40E+08	8.58E+08	2.30E+07
CEDE Inhalation DCF to gonads (rem/Ci)	1.92E+04	1.05E+04	3.03E+06	6.48E+05	4.22E+07	4.61E+06	1.13E+04	2.67E+06
One Year Lung DCF (rem/Ci)	1.25E+09	6.13E+08	3.29E+09	6.66E+08	1.42E+09	6.76E+08	1.66E+09	2.33E+06
One Year Marrow DCF (rem/Ci)	3.14E+05	1.59E+05	1.69E+08	1.55E+08	1.58E+08	2.84E+06	6.39E+08	9.22E+06

TABLE B-3
RADIONUCLIDE CONTENTS FOR TRANSPORTATION OPTIONS

Radionuclide	Raw Material (Ci/g)	Curies per Container (Ci)
Ac-227	7.69E-09	1.32E-02
Pa-231	4.04E-09	6.93E-03
Pb-210	2.02E-07	3.47E-01
Ra-226	4.77E-07	8.19E-01
Th-228	7.36E-09	1.26E-02
Th-230	7.62E-08	1.31E-01
U-235	9.40E-11	1.61E-04
U-238	1.12E-09	1.92E-03

RADTRAN5 requires data that expresses the likelihood of accidents of a given severity for urban, suburban, and rural population areas. These conditional probabilities are called "severity fractions" in RADTRAN, and there is an indexed "severity category" corresponding to each severity fraction. For each accident severity category, the user inputs data on the fraction of material that could be expected to be released from a container during an accident, the fraction of material released that can become airborne, and the fraction of airborne material that can become respirable. The accident release fractions for Silos 1 and 2 materials are presented in Table B-4. The airborne fraction and release fraction were obtained from the "American Society of Mechanical Engineers (ASME) Technical Peer Review Report on Airborne Release Fractions."

TABLE B-4
ACCIDENT RELEASE FRACTIONS - PROPOSED REVISED REMEDY

Severity Category	Release Fraction	Airborne Fraction	Respirable Fraction
1	0.0	N/A	N/A
2	0.0	N/A	N/A
3	3.125E-02	1.0E-04	5.0E-02
4	6.25E-02	1.0E-04	5.0E-02
5	1.25E-01	1.0E-04	5.0E-02
6	2.50E-01	1.0E-04	5.0E-02
7	5.00E-01	1.0E-04	5.0E-02
8	1	1.0E-04	5.0E-02

RISK EVALUATION - MODEL RESULTS

As stated previously, RADTRAN5 estimates the dose-risk to the public resulting from accident-free transport of radiological material and dose-risk to populations that are downwind from hypothetical releases associated with accidents of varying severity.

Table B-5 presents data on the estimated dose received by the maximally exposed individual and the cumulative dose received by the public resulting from accident-free transport of Silos 1 and 2 material. Table 5 also presents the estimated exposed population of the cumulative dose, which includes the population residing adjacent to the route, the population sharing the route, and the population at or near the rest stops.

TABLE B-5
ESTIMATED DOSE - ACCIDENT FREE TRANSPORT

Route		Maximum Exposed Individual (rem)	Cumulative Dose	
			Dose (person-rem)	Population
Direct Truck to the NTS	Southern	5.70E-03	2.00E+02	7.18E+05
	Northern	5.70E-03	1.68E+02	6.76E+05

For determining the incremental lifetime cancer risk (ILCR), the cumulative dose was evenly distributed amongst the exposed population to provide an average dose per individual. This was determined to be a reasonably exposed individual for calculating the ILCR compared to using the maximum exposed individual. The maximum exposed individual assumes one person is standing in the same spot for all shipments and is exposed to all shipments without the benefit of shielding, even from a building. This is not a realistic scenario to expect during transportation of the Silos 1 and 2 materials and is considered inconsistent with the intent of the definition of a reasonably exposed individual presented in the NCP. Therefore, the ILCR was calculated using an even distribution of the cumulative dose over the exposed population.

The risk from exposure to ionizing radiation is measured in latent cancer fatalities (LCF), which is the number of potential cancer fatalities estimated as a result of radiation exposure. An incremental lifetime cancer risk (ILCR) - the increased potential of an individual developing a cancer over a lifetime as a result of exposure - can be determined by comparing the potential number of cancers against the total exposed population. LCFs are calculated by Eq.1.

$$LCF = H_E \bullet CRF \quad \text{(Eq. 1)}$$

where,

H_E = collective effective dose equivalent for exposed population

LCF = latent cancer fatalities

CRF = cancer risk factor, LCF/person-rem

The cancer risk factor for members of the public is 5×10^{-4} per rem. These values are used in the RADTRAN5 computer model and are from the latest edition of ICRP-30.

Table B-6 presents the estimated ILCRs calculated for the reasonably exposed individual resulting from the dose received during accident-free transportation. The dose to the reasonably exposed individual was calculated by evenly distributing the cumulative dose over the exposed population to derive an average dose.

TABLE B-6
ILCR FOR REASONABLY EXPOSED MEMBER OF PUBLIC – ACCIDENT FREE TRANSPORT

Route	Dose (person-rem)	ILCR
Southern Route	2.79E-04	1.40E-07
Northern Route	2.49E-04	1.25E-07

RADTRAN5 also calculates the dose risk to the public based on exposure from a hypothetical accident. Dose risk from an accident includes the conditional probability of an accident of a particular severity. The population dose risk units are reported in person-rem. As with accident-free transportation, the resulting dose-risk is a cumulative dose over an exposed population. The cumulative dose is determined from the sum of the product of the probability of an accident occurring and the resulting dose to the public from the accident. As stated previously, there are eight classes of severity for accidents ranging from high probability, low consequence accidents (Severity Class 1) to low probability, high consequence accidents (Severity Class 8). Class 1 and 2 accidents do not result in any exposure to the public because the container remains intact. Classes 3 through 8 result in increased exposure due to the increased amount of material released from the package, which at a Severity Class 8 is a total loss of containment of both containers on the shipment. Tables B-7 and B-8 present the estimated risk to the population resulting from a hypothetical accident for each transportation route alternative. The tables present the probability of a specific severity category accident occurring, the dose-risk to the exposed population resulting from the accident, and the ILCR assuming an even distribution of dose across the exposed population.

TABLE B-7
ESTIMATED RISK TO EXPOSED POPULATION – HYPOTHETICAL ACCIDENT SOUTHERN ROUTE TO THE NTS

Population Distribution

(Persons under the plume footprint for a single accident)

Suburban	3.17E+05
Rural	2.00E+04
Urban	2.48E+06

Accident Severity Class	Accident Probability			Dose-Risk (person-rem)			Individual Risk (ILCR)		
	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban
3	1.33E-01	5.45E-01	2.52E-03	3.52E-03	2.22E-04	1.77E-02	5.55E-12	5.55E-12	3.58E-12
4	3.04E-02	1.25E-01	5.77E-04	7.07E-03	4.45E-04	3.55E-02	1.12E-11	1.11E-11	7.16E-12
5	3.99E-03	3.65E-02	6.73E-05	1.41E-02	8.93E-04	7.10E-02	2.23E-11	2.23E-11	1.43E-11
6	1.05E-03	2.00E-02	1.33E-05	2.82E-02	1.79E-03	1.41E-01	4.45E-11	4.46E-11	2.85E-11
7	4.04E-05	1.77E-03	1.03E-06	5.64E-02	3.56E-03	2.83E-01	8.90E-11	8.90E-11	5.70E-11
8	3.57E-06	3.50E-04	9.02E-08	1.13E-01	7.11E-03	5.69E-01	1.78E-10	1.78E-10	1.15E-10

TABLE B-8
ESTIMATED RISK TO EXPOSED POPULATION – HYPOTHETICAL ACCIDENT NORTHERN ROUTE TO THE NTS

Population Distribution

(Persons under the plume footprint for a single accident)

Suburban	4.62E+05
Rural	1.19E+04
Urban	2.93E+06

Accident Severity Class	Accident Probability			Dose-Risk (person-rem)			Individual Risk (ILCR)		
	Suburban	Rural	Urban	Suburban	Rural	Urban	Suburban	Rural	Urban
3	1.34E-01	5.85E-01	1.24E-03	5.12E-03	1.33E-04	2.10E-02	5.54E-12	5.57E-12	3.58E-12
4	3.06E-02	1.34E-01	2.83E-04	1.03E-02	2.66E-04	4.20E-02	1.11E-11	1.12E-11	7.18E-12
5	4.01E-03	3.92E-02	3.30E-05	2.06E-02	5.31E-04	8.42E-02	2.23E-11	2.23E-11	1.44E-11
6	1.05E-03	2.15E-02	6.50E-06	4.12E-02	1.06E-03	1.68E-01	4.46E-11	4.46E-11	2.86E-11
7	4.06E-05	1.90E-03	2.64E-07	8.23E-02	2.12E-03	3.36E-01	8.90E-11	8.91E-11	5.74E-11
8	3.58E-06	3.75E-04	4.42E-08	1.65E-01	4.27E-03	6.74E-01	1.78E-10	1.79E-10	1.15E-10

For the hypothetical accident scenario, the highest ILCR to the reasonably maximum exposed individual occurs as a result of a Severity Category 8 accident. The highest ILCR resulting from a Severity Category 8 accident occurs in rural and suburban areas for each proposed trucking route. For shipping Silos 1 and 2 materials, the highest ILCR is estimated to be 1.78E-10.

For each accident severity category, RADTRAN5 also calculates the maximum individual downwind doses at the mean downwind centerline distance for each isopleth. The individual doses calculated are a sum of the cloudshine, inhalation, and groundshine exposure pathways. The calculated values can be used to determine whether Federal exposure guidelines might be exceeded and, if so, at what distances from the accident site. The DOE limits for annual exposure are a total effective dose equivalent for an occupational worker of 5 rem and 0.1 rem for occupational workers who are minors and members of the public. These limits are typically applied to routine operations at DOE facilities and not to accidents.

In addition, RADTRAN5 is typically used only to estimate dose to members of the public during an accident and not to hazardous material responders. The accident-scenario dose levels calculated by RADTRAN5 for members of the public assume that evacuation requires 24 hours. These same 24-hour dose levels can be applied to first responders wearing no personal protective equipment, or can be interpolated based on a reasonable time of exposure to first responders before they don the appropriate protective equipment. Based on the doses calculated by RADTRAN5, there would not be any exposures resulting from an accident involving shipment of treated Silos 1 and 2 materials that would exceed Federal exposure limits for either occupational workers or members of the public.

Assuming a 24-hour exposure without any personal protective equipment, an occupational worker, or first responder would be exposed to 100% of the external dose associated with the released material and be exposed to 100% of the respirable material released. It must be recognized that although the very conservative assumptions described here assume a 24-hour exposure without any personal protective equipment, first responders are trained to assure that the proper protective equipment is in place prior to approaching an accident scene, and to immediately establish controlled access to the accident to prevent access by workers and members of the public without protective equipment. Further, the actual likelihood that a 24-hour period would be required for a member of the public to be evacuated from the accident site is extremely small.

TABLE B-9
MAXIMUM INDIVIDUAL 24-HOUR DOSE - HYPOTHETICAL ACCIDENT SHIPMENTS TO THE NTS

Centerline (meters)	Severity Category 3	Severity Category 4	Severity Category 5	Severity Category 6	Severity Category 7	Severity Category 8
33	2.64E-04	5.29E-04	1.06E-03	2.12E-03	4.24E-03	8.47E-03
68	1.33E-04	2.66E-04	5.32E-04	1.06E-03	2.13E-03	4.25E-03
105	6.45E-05	1.29E-04	2.58E-04	5.17E-04	1.03E-03	2.07E-03
244	2.49E-05	5.00E-05	9.99E-05	2.00E-04	4.00E-04	7.99E-04
369	1.20E-05	2.40E-05	4.79E-05	9.58E-05	1.92E-04	3.83E-04
561	5.70E-06	1.14E-05	2.28E-05	4.57E-05	9.13E-05	1.83E-04
1020	2.16E-06	4.33E-06	8.67E-06	1.73E-05	3.47E-05	6.93E-05
1630	1.02E-06	2.05E-06	4.10E-06	8.21E-06	1.64E-05	3.28E-05
2310	4.76E-07	9.54E-07	1.91E-06	3.82E-06	7.64E-06	1.53E-05
4270	1.80E-07	3.61E-07	7.21E-07	1.44E-06	2.88E-06	5.77E-06
5470	8.20E-08	1.64E-07	3.29E-07	6.57E-07	1.31E-06	2.63E-06
11100	3.89E-08	7.80E-08	1.56E-07	3.12E-07	6.24E-07	1.25E-06
13100	1.44E-08	2.88E-08	5.76E-08	1.15E-07	2.31E-07	4.61E-07
21300	6.78E-09	1.36E-08	2.72E-08	5.43E-08	1.09E-07	2.17E-07
40500	3.10E-09	6.21E-09	1.24E-08	2.48E-08	4.96E-08	9.93E-08
70000	1.65E-09	3.31E-09	6.63E-09	1.33E-08	2.65E-08	5.30E-08
89900	1.01E-09	2.02E-09	4.04E-09	8.09E-09	1.62E-08	3.23E-08
121000	6.60E-10	1.32E-09	2.64E-09	5.29E-09	1.06E-08	2.12E-08

FINDINGS AND CONCLUSIONS

The short-term transportation risk evaluation indicates that each of the proposed transportation routes to the NTS in conjunction with the treatment method and the shipping and disposal container meet the 1×10^{-4} to 1×10^{-6} ILCR threshold condition established by the U.S. Environmental Protection Agency for sites being remediated under the Comprehensive Environmental Response Compensation and Liability Act.

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